From Mutually Non-Blocking to Switched Non-Blocking DES

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RÉSUMÉ. *La propriété de système à événements discrets mutuellement non-bloquants a été introduite par Fabian and Kumar (1997). Dans ce papier, nous proposons une extension de cette propriété de 2 à 3 éléments. Nous donnons ensuite une définition de système non-bloquant par commutations, et nous montrons que la propriété "mutuellement non-bloquant" est incluse dans celle de "non-bloquant par commutations". Nous illustrons ce resultat à travers un exemple de système de conversion de protocole, dans lequel le protocole commute entre deux spécifications.*

ABSTRACT. *The mutually non-blocking property of discrete-event systems has been introduced by Fabian and Kumar (1997). In this paper, we extend the property of mutually non-blocking from 2 to 3 elements. We also propose a definition of switched non-blocking system, and we show the mutually non-blocking property is included in the switched non-blocking property. We illustrate the result with an example of protocol conversion with switched specification.*

MOTS-CLÉS : *Systèmes à événements discrets; non-blocage mutuel; non-blocage par commutations.*

KEYWORDS: *Discrete-event systems; mutually non-blocking; switched non-blocking.*

1. Introduction

Supervisory control initiated by Ramadge and Wonham (Ramadge and Wonham, 1987) provides a systematic approach for the control of discrete event system (DES) plant. There has been a considerable work in the DES community since this seminal paper. On the other hand, from the domain of continuous-time system, hybrid and switched systems have received a growing interests (Liberzon, 2003). The notion of

switching is an important feature that has to be taken into account, not only in the continuous-time domain but for the DES area too.

In a communication system, a protocol mismatch occurs when the sending and receiving parts use different protocols. A converter is introduced to correct the mismatch between the two different protocols. Correcting means removing by disabling undesirable traces. The example is taken from (Fabian and Kumar, 1997). A survey on the different approaches of communication conversion can be found in (Roop et al., 2009).

As for non-blocking property, there exist different approaches. The first one is the non-blocking property defined in (Ramadge and Wonham, 1987). Since then other types of non-blocking have been defined. The mutually non-blocking property has been proposed in (Fabian and Kumar, 1997) and (Fabian and Kumar, 2000). Other approaches of mutually and globally nonblocking supervision with application to switching control is proposed in (Kumar et al., 2005). Robust non-blocking supervisory control has been proposed in (Bourdon et al., 2005). Other types of non-blocking include the generalised non-blocking property studied in (Malik and Leduc, 2008). Finally discrete-event modeling with switching max-plus systems is proposed in (van den Boom and de Schutter, 2006) while an example of mode switching DES is described in (Faraut-et-al., 2009).

2. Main Results

In this paper, we propose an extension of the mutually non-blocking property, from 2 elements to 3 elements and a definition of switched non-blocking property.

The extension of the mutually non-blocking property from 2 to 3 elements is quite straightforward, since we say that 3 elements (or languages) are mutually non-blocking if they are pairwise mutually non-blocking.

We propose then a definition of weakly switched non-blocking system. We say that a language H is *weakly non-blocking* if we can find a non-empty sublanguage $H_i \subseteq H$ such that the concatenation of H_i, intersected alternatively with the first specification language K_1 and with the second specification language K_2 is in the marked states of the system. The definition of switched non-blocking system follows from the previous definition. A system is *switched non-blocking* if it is weakly non-blocking and if the sublanguage is the entire language itself, i.e., $H_i = H$.

We show that the mutually non-blocking property is included in the switched non-blocking property. And we illustrate our result with an example of protocol conversion problem where the converter (the supervisor) deals with two different protocol specifications that switch between them.

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